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13. ABSTRACT *(Maximum 200 words)*

Although several countries dispose of their radioactive waste in the world's oceans, recent revelations by the former Soviet Union concerning disposal of radioactive waste in the shallow water of the Kara Sea have created widespread environmental concern. The Yablokov Report or the White Book is the official Russian documentation of source locations, the time of dumping and the amounts and types of radioactive materials that have been dumped. The report states that low level liquid waste was dumped into the Kara and Barents Seas with lesser amounts dumped into the White Sea and the Baltic. Low to intermediate waste was dumped into the Kara and Barents Seas. The material assumed the most environmentally hazardous was solid radioactive waste with spent nuclear fuel. Nuclear reactors containing the spent nuclear fuel were deposited along the eastern coast of Novaya Zemlya island in water with average depths between 20-40 m. Major river/estuary systems located in the Kara and Barents Seas, particularly the larger Ob and Yenisei rivers as well as the smaller Pechora river, are additional sources. The disposal of liquid radioactive waste at the Sellafield site in the Irish Sea has also been suggested as a source of radioactivity for the Barents and the Kara Sea.

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Modeling the Dispersion of Radioactive Contaminants in the Arctic Using a Coupled Ice-ocean Model

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Although several countries dispose of their radioactive waste in the world's oceans, recent revelations by the former Soviet Union concerning disposal of radioactive waste in the shallow water of the Kara Sea have created widespread environmental concern. The Yablokov Report or the White Book is the official Russian documentation of source locations, the time of dumping and the amounts and types of radioactive materials that have been dumped. The report states that low level liquid waste was dumped into the Kara and Barents Seas with lesser amounts dumped into the White Sea and the Baltic. Low to intermediate waste was dumped into the Kara and Barents Seas. The material assumed the most environmentally hazardous was solid radioactive waste with spent nuclear fuel. Nuclear reactors containing the spent nuclear fuel were deposited along the eastern coast of Novaya Zemlya island in water with average depths between 20-40 m. Major river/estuary systems located in the Kara and Barents Seas, particularly the larger Ob and Yenisei rivers as well as the smaller Pechora river, are additional sources. The disposal of liquid radioactive waste at the Sellafield site in the Irish Sea has also been suggested as a source of radioactivity for the Barents and the Kara Sea.

Numerical models can be useful tools in studying the problem of the possible disperson of radioactive contaminants in the Arctic. Modeling efforts are underway in both the Arctic Nuclear Waste Assessment Program and the International Atomic Energy Agency's (IAEA) modeling program. The IAEA's modeling efforts are focused on the use of box type models in the Kara, Barents, Greenland/Norwegian Seas and in the Arctic basin. At present, several benchmarking studies are being conducted with these box models (IAEA Modeling Group, 1994) by scientists from Denmark, Japan, the Netherlands, Russia, the United Kingdom and the IAEA in Monaco. These benchmark scenarios consist of instantaneous release and constant release cases. Future more realistic model tests using source scenarios suggested by the IAEA's "Source Term Group" will be performed in the near future.

Within the ANWAP, a variety of modeling studies are being conducted. River system modeling is being formed by Paluszkiewicz et al., river plumes are being modeled by Morison and Brooks, basin scale models (Kara Sea) are being developed by Smith, modeling of sea ice as a transport mechanism is being conducted by Coon et al., large scale modeling of the Arctic and it's marginal seas is being addressed by Preller and Cheng and modeling of possible release scenarios from the dumped reactors is being performed by Mount in conjunction with the IAEA "Source Term Group".

This presentation will contain details of the large scale modeling of the Arctic and its marginal seas by the Naval Research Laboratory. This effort makes use of a coupled ice-ocean model composed of the Cox ocean model coupled to the Hibler ice model. The model domain extends from the pole to approximately 30 N latitude and uses a grid resolution of 0.28 degrees in the horizontal and 15 levels in the vertical. The source locations and total amounts of radioactive material dumped are based on those presented in the Yablokov report. In the first part of this study, the ocean model is separated from the ice model to concentrate only on the dispersion of the contaminants once they have entered the water column.

Several different ten-year ocean model simulations are presented using the following source locations 1) the Ob and Yenisei Rivers, 2) solid and liquid dumpsites in the Kara Sea, 3) the Sellafield site located in the Irish Sea and 4) several site locations near the Sea of Japan and the Sea of Okhotsk. A constant release rate is created for each source in the Kara and Barents Seas based on the total amount dumped and the length of time over which it was dumped. In the Sellafield case, constant yearly release rates were used based on documented releases for each year from 1971-1980. Model simulations indicate that there are "preferred pathways" from Kara Sea source. In particular, radionuclides in the surface level of the ocean model travel most rapidly in three direction. The first pathway is out of the Kara Sea, along the Arctic basin just north of the Barents Sea, across the northern coast of Spitzbergen through the Fram Strait and along the East Greenland coast. The second pathway is out of the Kara Sea into the Arctic basin, across the north pole and then toward the northern Canadian and Alaskan coasts. The third pathway is out of the Kara into the Laptev Sea continuing into the East Siberian Sea. The Kara Sea is the region of highest levels of radioactivity in all simulations using Kara and Barents Sea sources. Levels of radioactivity near the Alaskan coast are approximately five orders of magnitude less than those found in the Kara Sea. Pathways taken by radionuclides released in the model at the Sellafield site agree with observations. These radionuclides are carried from the source location long the Norwegian coast into the Greenland Sea and from the Norwegian coast into the Barents Sea. Weaker levels of radionuclides are also found in the Kara Sea from the Sellafield source.

Ice model simulations using daily winds from 1992 are used to determine alternate pathways taken by radionuclides assuming they have become trapped in the ice via sediment uptake. These preliminary simulations show that several parcels of ice do leave the Kara Sea during this period, but a majority stay in near the source. Further simulations in time will be necessary to determine the full extend of the transport of radionuclides by sea ice.